BIOCOMPATIBLE ADHESIVE COMPOSITIONS

CROSS REFERENCES

This application is a division of U.S. application Ser. No. 08/573,801, filed Dec. 18, 1995, now pending, which is a continuation-in-part of U.S. application Ser. No. 08/476,825, filed Jun. 7, 1995, now U.S. Pat. No. 5,614,587, which is a continuation-in-part of allowed U.S. application Ser. No. 08/147,227, filed Nov. 3, 1993, now U.S. Pat. No. 5,565,519, which is a continuation-in-part of U.S. Ser. No. 922,541, filed Jul. 30, 1992 now U.S. Pat. No. 5,328,955, issued Jul. 12, 1994, which is a continuation-in-part of U.S. Ser. No. 433,441, filed Nov. 14, 1989, now U.S. Pat. No. 5,328,955, issued Nov. 10, 1992, which is a continuation-in-part of U.S. application Ser. No. 07/274,071, filed Nov. 21, 1988, subsequently abandoned, which applications and issued patents are incorporated herein by reference in full, and to which currently pending application we claim priority under 35 U.S.C. § 120.

FIELD OF THE INVENTION

This invention relates generally to compositions useful as biological or surgical adhesives; more specifically, it relates to bioadhesive compositions comprising collagen crosslinked using a multifunctionally activated synthetic hydrophilic polymer, as well as methods of using such compositions to effect adhesion between a first surface and a second surface, wherein at least one of the first and second surfaces is preferably a native tissue surface, and methods of using such compositions to prevent the formation of adhesions following surgery.

BACKGROUND OF THE INVENTION

U.S. Pat. No. 5,024,742, issued Jun. 18, 1991, to Nesburn et al., discloses a method of crosslinking amino acid-containing polymers with photoactivatable, heterobifunctional crosslinking agents, the crosslinking agents having a photoactivatable site and a conventional site, comprising: i) selecting one or more amino acid-containing polymers; and ii) combining the polymers with the crosslinking agents such that the conventional site on the crosslinking agent is bound to the polymer and the photoactivatable site is unbound. Upon photoactivation, crosslinks are formed when the photoactive site binds to another amino acid-containing polymer. The resulting crosslinked collagen composition can be used as a bioadhesive for sutureless closures of the eye or any other wound.

U.S. Pat. No. 5,156,613, issued Oct. 20, 1992, to Sawyer, discloses a method of joining or reconstructing biological tissue comprising applying energy to the tissue while providing a filler material to is and denaturing or melting the material and adjacent biological tissue with the energy to cause mixing of the denatured or melted filler material and tissue, thus joining or reconstructing the tissue. Also claimed is a method of joining or reconstructing biological tissue comprising applying optical or radio frequency energy while providing a collagen filler material to the biological tissue; denaturing or melting the collagen and adjacent tissue with the applied energy to cause mixing of the denatured or melted collagen and tissue; and joining or reconstructing the tissue.

U.S. Pat. No. 5,162,430, issued Nov. 10, 1992, to Rhee et al., and commonly owned by the assignee of the present invention, discloses collagen—synthetic polymer conjugates prepared by covalently binding collagen to synthetic hydrophilic polymers such as various derivatives of polyethylene glycol.

U.S. Pat. No. 5,192,316, issued Mar. 9, 1993, to Ting, discloses a lens for implantation directly on the Bowman's membrane of a live cornea to correct the optical properties of the eye. The lens is made of a synthetic polymer which is permeable to water and forms a hydrogel. The lens preferably includes an additive to increase the adhesion of the lens to the cornea and/or to stimulate the growth of epithelial cells. The additive may be fibronectin, collagen, cell fastening protein, antigelatin factor, a biologically active peptide, cold insoluble globulin, chondronectin, laminin, epithelial growth factor (EGF), or a mixture thereof.

U.S. Pat. No. 5,209,776, issued May 11, 1993, to Bass et al., discloses a composition for bonding separated tissues together or for coating tissues or prosthetic materials comprising: i) at least one first component selected from natural or synthetic peptides, modified, crosslinked, cleaved, or shortened variants or derivatives, and ii) at least one second component, which is different from the first component, adapted to support the first component to form a matrix, sol, or gel with the first component. The first component may be, for example, albumin, alpha-globulins, beta-globulins, gamma-globulins, transthyretin, fibrinogen, thrombin, collagen, elastin, keratin, fibroin, fibrin, or fibronectin. The second component may be, for example, hyaluronic acid, chondroitin sulfate, dermatan sulfate, keratan sulfate, heparin, heparan sulfate, collagen, fructose, dextrans, agarose, alginic acid, pectins, methylcellulose, hydroxycellulose, hydroxypropylmethylcelulose, hydroxyethylecellulose, CMC, glycerin, mannitol, sorbitol, polyvinylalcohol, or polyethylene glycol.

U.S. Pat. No. 5,219,895, issued Jun. 15, 1993, to DeVore et al., discloses a collagen composition, useful as an adhesive for medical applications, wherein the composition is formed by the polymerization of derivatized collagen, modified with an acylating agent and/or a sulfonating agent. The polymerization is performed by explosive UV irradiation, fluorescent light, and/or an initiator. The acylating agent may be glutaric anhydride, succinic anhydride, lauric anhydride, diglycolic anhydride, methyl succinic anhydride, methyl glutaric anhydride, dimethyl glutaric anhydride, or exo-3,6-epoxy-1,2,3,4-tetrahydrophthalic anhydride. Bonding of soft tissue comprises applying a polymerizable collagen composition onto at least a portion of a surface of at least one of a first and second tissue; exposing the tissue surface to an initiator to polymerize the collagen; and contacting the two tissues to form a bond between them.

U.S. Pat. No. 5,290,552, issued Mar. 1, 1994, to Brown et al., discloses a surgical adhesive composition comprising fibrinogen, factor XIII, collagen, thrombin, and Ca^{2+} ions in an aqueous medium. The collagen is fibrillar, is insoluble at pH values about 5, is flowable, has the native helical structure of collagen fibrils, and is capable of causing gelation of the adhesive. The thrombin and Ca^{2+} are present in an amount sufficient to catalyze polymerization of the fibrinogen to form a clot.

Commonly owned U.S. Pat. No. 5,328,955, issued Jul. 12, 1994, to Rhee et al., discloses various activated forms of polyethylene glycol and various linkages which can be used to produce collagen—synthetic polymer conjugates having a range of physical and chemical properties.

European patent publication No. 341007, to Matrix Pharmaceuticals, Inc., discloses a surgical adhesive composition comprising, in an aqueous composition, plasma from the patient to be treated, collagen in an amount sufficient to